SOME FACTORS AFFECTING THE ESTABLISHMENT AND GROWTH OF BUD GRAFTS OF ROSES

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Philip Caldwell Gardner

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ABSTRACT

A brief review of abnormal growth of rose scion buds and the high proportion of buds which fail to produce normal growth in the production of rose plants by bud-grafting in New Zealand, introduces the subject.

The history of investigations, prior to 1968, into this problem is outlined. A description of normal growth patterns of shoots on roses, of axillary buds and of production methods in New Zealand is followed by a detailed description of the abnormal teratomatous growth, known as proliferation, which is characteristic of a proportion of affected buds.

The proposal is put forward that this condition is caused by infection with an organism that initiates galling similar in appearance to crown gall and that subsequent symptoms develop consequent to such a tumorous transformation but not necessarily due to the continued presence of the causal organism. In this study no causal organism was successfully isolated. The claims of a number of possible other causal agents are examined including development of the graft union, chemical factors, non-transforming bacteria, mites, fungi and viruses. Reasons are advanced why none of these provide a satisfactory explanation in agreement with experimental and observational evidence. This evidence is discussed in relation to the etiology and development of the disease syndrome.

The evidence presented is strongly in support of

a tumorous transformation, initiated by a soil-borne pathogen, occurring at the proximal end of the original stock cutting at the time of its insertion in the ground. Root initiation may be restricted by the position of the gall and the first shoot growth at the top of the stock may show slight symptoms. The infected plant is predisposed to show subsequent symptoms but these are dependent on subsequent operations and the time and conditions when they are carried out. These symptoms are the development of excessive callus at the point of excision of the stock top and at the incision of the bud-graft, the production of teratomatous shoots, known as proliferation, by the scion bud or failure of the scion bud to grow despite a successful graft union. These symptoms may be reduced or prevented by successful normal growth of the scion. A comparison of the etiology and development of the syndrome of proliferation disease is made with the classical characteristics of the crown gall syndrome. Recent research publications on crown gall are reviewed to establish that recent findings are not contrary to the proposal that rose proliferation disease is caused in a manner directly analagous to crown gall. It is proposed that the evidence supports the assumption that a particular strain of Agrobacterium tumefaciens or some bacterium closely related to it is the etiological agent causing rose proliferation disease.

PREFACE

An investigation of this nature involving woody plants and a seasonal expression of symptoms tends to spread over several years. The failure to isolate a causal organism is perhaps a reflection of the difficulty of the task. The failure of other researchers to achieve that end is perhaps some consolation. The lack of a nicely "sewn up" cause and effect has led to the involvement of a wide range of disciplines. The broadness of the field covered and the vast amount of possibly relevant information has prevented the carrying of many aspects of the investigation to any great depth and the description has accordingly tended to be disjointed. Over two thousand references have been card indexed and assessed but limitations of space and time have prevented the inclusion of more than a couple of hundred of the more pertinent ones in this thesis.

I must express my thanks to Professor R. Thomas and the Botany Department at Massey University for their patience. In particular to V. Sarafis whose thought provoking comments were a constant source of inspiration. Thanks are also due to Dr. A. Rainbow for his co-operation with his own research work and results on the same site, to Drs. .R. Elliott, M. Dye, D. Dye, P. Fry and K. Hammett at PDD whose comments and the opportunity to view and assess some of their experiments was most helpful. Members of the Nursery Industry throughout New Zealand have always

willingly given me the opportunity to make observations and assessments on their crops and made the results of their stock trials available for analysis.

As the former President of the United States, T. Roosevelt once said "scientists are those who view one another's work with quarrelsome interest." The inclusion of anyone's name in these acknowledgments does not necessarily infer that they agree with, or condone any, of the expressions of opinion or interpretations contained in this thesis, they are entirely my own.

Last but not least my thanks to my wife and family for their patience and long-suffering understanding.

P.C. Gardner,

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INTRODUCTION:

At least since 1954 and probably earlier, many commercial rose plant producing nurseries in New Zealand have been faced with increased failures of bud-grafts, following the bud grafting operation and in the early stages of scion growth, as compared with a relatively low proportion of failures in earlier years. Some of the scion buds which start into growth and subsequently fail exhibit a striking teratomatous growth pattern of the "Witches Broom" type. A very high proportion of bud failures and losses of scion shoots occur in nurseries in association with these abnormal growths and the total losses may be up to 90%.

Despite considerable investigation by a number of workers no completely satisfactory explanation of the cause of these teratomata has been published to date.

Perhaps coloured by memories of the "good old days" older nurserymen maintain that 90 to 95% bud take and 80 to 90% saleable yield used to be normal in rose production. Since the onset of these problems, and no doubt there are several, yields of as low as 10% saleable bushes have been recorded with a usual yield in most nurseries of 50% $\pm$ 25%. Many nurseries with heavy losses have given up growing roses as an uneconomic crop.

Occurring over the same period and no doubt

associated with some of the nursery problems there has been an increasing incidence of decline of rose bushes after transplanting into their permanent position.

Due to the involvement of several different diseases, some of which may have symptoms in common, it is not surprising that there has been considerable confusion of terminology both in describing symptoms and in naming the diseases involved. In this paper the terms will be used in the following senses.

The symptoms which may occur due to various causes are defined as follows:-

Blow Out is not strictly a symptom or a disease but the mechanical breaking off of a scion in the vicinity of the graft union caused by wind pressure.

Proliferation is the symptom of multiple shooting from the scion bud with the leaf lamina either vestigial or reduced in size with a reduced number of leaflets giving a "witches broom" type teratomatous growth (Figs. 8 & 9).*

Pinch off refers to the symptoms originally described by Roberts (165)* under that name of which the salient characteristic is that, despite an apparent successful

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*Note: Numbers in brackets refer to the appropriate references in the bibliography. Capital letters in brackets refer to the appropriate appendices. Figure and table references are prefixed with "Fig." or "Table" as appropriate.

graft between the bud shield and the stock, the scion shoots fail due to a rupture of the shoots from the bud shield because of anatomical weakness at the base of the rapidly expanding shoot.

Graft failure is a failure to establish a union between the bud shield and the stock. This may be due to a number of causes such as poor budding technique, loose tying, drying out, presence of various pathogens at the graft interface and others.

Bud failure is a symptom which refers to those cases where a more or less successful union is established. between the stock and scion shield but the bud itself fails to grow while the shield may remain alive for some time.

Die back is a symptom which may arise due to a number of causes and merely refers to the basipetal dying back of a shoot from the tip.

Rosetting is used to describe the characteristic appearance of a single shoot in which the internode lengths are grossly reduced to give a tightly packed rosette of leaves. This condition is quite distinct from a superficially similar effect due to several shoots arising from the same node (Fig. 21).

Epinasty is used in its ordinary botanical sense for a down-bending of the petiole unless referred specifically to other organs and may be due to a number of causes.

Excessive Callus refers to tissue similar in macroscopic appearance to wound healing periderm but appearing in considerably greater volume than is normal for wound

healing in the species under consideration (Fig. 18).
Galling is used as a general term to refer to any large (3 to 50 mm or more in diameter) tissue growths usually more or less nodular in structure and which only have a narrow point of attachment to the plant. Galls may occur below ground in which case the tissues are relatively soft and white with exposed actively growing cells on the surface (Figs. 11 & 14), or they may occur above ground when they usually have a corky, brown or greenish surface and are generally harder in texture (Figs. 19 & 20). These differences appear to be due to microenvironmental conditions. A gall at ground level may exhibit below ground characteristics where it is immersed in the soil and above ground characteristics where it is exposed. The general term galls includes tumors.
Tumor is used in a more restricted sense than gall to apply to autonomous gall growths including genetical tumors and crown gall transformation tumors. Tumor-like would accordingly mean having the appearance of such tumors (Figs. 11 & 14).

Diseases which appear to be primarily caused by a single etiological factor are referred to as follows:-
Blast is used only to refer to the disease caused by Pseudomonas syringae van Hall.
Crown Gall is used only to refer to the disease, characterised by tumors and associated symptoms, caused by the crown gall bacterium, Agrobacterium tumefaciens (Sm. & Townsd.) Conn.